Scientific Certainty and Best Available Science

DISB has begun discussing approaches to assessing the quality and reliability of science and other information that provides a basis for the Delta Plan. We have considered approaches taken by the Millennium Ecosystem Assessment, the Intergovernmental Panel on Climate Change, the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP), and materials in draft Chapter 4 (Science and Adaptive Management for a Changing Delta) of the Delta Plan. Although the DISB came to no final conclusion about the best approach and intends to continue its discussion of this issue at subsequent meetings, it found that both the DRERIP and Chapter 4 approaches have promise. Here we summarize and comment on some key aspects of these approaches.

The DRERIP approach was designed to prioritize restoration actions in the Delta. Assessing whether to proceed with a restoration action was based on three, science-based, elements, one of which was an approach to scoring scientific certainty based on an evaluation of the level of scientific understanding and the predictability of ecosystem or species response to a management intervention.

Scientific understanding refers to the extent to which cause and effect relationships have been validated through scientific investigation. Understanding may be limited by lack of scientific information, contradictory information, or because relationships that have been studied elsewhere have not been validated in the Delta. Predictability refers to the degree to which scientific understanding can be used to predict how the system will respond to particular management actions. Understanding and predictability are related but not identical. For example, understanding of a process may be good, but because of inherent variability in the system predictability may still be low. An example is the variation in annual recruitment of Delta smelt. Although the recruitment process and the factors affecting recruitment are reasonably well understood, the ways that these interact to drive year-to-year differences in recruitment are difficult to predict.

DRERIP scored scientific certainty of the outcome of a restoration action (the combination of understanding and predictability) in 4 categories:
1. High Certainty (Understanding and predictability are both high. Understanding is based on peer-reviewed studies from within the Delta, and the scientific reasoning is accepted by most scientists within the region. Cause and effect relationships have low variability so that outcomes are fairly certain and/or the restoration action is likely to confer benefits at times or under conditions when the benefits are most needed);
2. Medium Certainty (Understanding is high but predictability low to moderate; or understanding is moderate (e.g., based mainly on peer-reviewed studies of other systems) and predictability high to moderate);
3. Low Certainty (Understanding and predictability are low to medium. Understanding may be based on studies that have not been peer-reviewed. Relevant cause/effect relationships may be highly variable);
4. Minimal Certainty (Understanding is low; its scientific basis lacking or contradictory. Predictability is low or non-existent. Scientists do not agree on the conceptual model).

The DRERIP approach was designed to evaluate proposed restoration actions in the CALFED Ecosystem Restoration Plan. In concept, however, it can be applied to the broader requirements for assessing scientific certainty in the Delta Plan. The conceptual models developed for DRERIP, in particular, were put together by regional experts and incorporate the best scientific information available at the time they were constructed. They are also all peer-reviewed and well documented in terms of their scientific foundation. These models and the DRERIP process are valuable tools for assessing the effectiveness of a broad array of restoration actions likely to be included in the Delta Plan. Where DRERIP did not develop a relevant model, Delta Plan could still utilize the process for judging the scientific basis of the decisions, Ideally, model development would be a preliminary step. As the Delta Plan will adopt adaptive management, which demands conceptual models of the processes to be managed, the DRERIP approach is fully consistent with the requirements of the Delta Plan.

Chapter 4 of the Delta Plan focuses on assessment of best available science characterized as follows:

1. Best available science is time specific. It is the best science available at the time a decision is made. There is no expectation that decisions will be delayed until any particular level of scientific understanding is achieved. Thus, best available science may be derived from unpublished studies or even anecdotal information if that is all that is available.
2. Best available science changes over time and decisions may need to be revisited as scientific understanding evolves.
3. Best available science is consistent with a rigorous application of the scientific method and has been subject to a rigorous peer review. This is the level of scientific credibility usually associated with publication in a recognized scientific journal. However, unpublished studies that achieve the same level of methodological rigor and review are just as reliable.

Taking into account criteria for defining and assessing best available science developed by National Research Council and Washington State, Chapter 4 suggests 6 criteria for documenting the quality of science underlying decisions for the Delta:

1. Relevance – High quality information from the Delta that addresses the specific ecosystem attribute or species of concern is of greatest value. When Delta-specific information is not available, high quality information from analogous ecosystems elsewhere may be the best alternative.
2. Inclusiveness – Analyses should examine all relevant information across all relevant disciplines. Conflicting information should be clearly identified.
3. Objectivity – The information used should meet the standards of the scientific method. Information that does not meet these standards should be avoided unless it is the only information available.
4. Transparency and Openness – Information sources and analysis methods need to be clearly identified. Opportunity for public and professional comment on the science and analyses is desirable. Known limitations of the research should be identified.
5. Timeliness – More recent information is more relevant to decisions than older information, provided it is of equal quality. Emerging information may be relevant, particularly if it is contradictory to established information.

6. Peer Review – The quality of the science used in decisions is measured by the quality and thoroughness of its peer review. Information from various sources synthesized to support decisions should be peer reviewed even if the original sources were themselves peer reviewed.

The above standards and criteria represent the ideal and may not always be achieved. However, they provide a benchmark to which decision makers should strive. Provided actions are implemented within an adaptive management framework, continual review and updating of the information base will be imbedded in the ongoing decision-making process. In an adaptive management framework, the information base for decisions should continually improve. However, improvement will only be assured if projects adhere as closely as possible to the kind of information standards described above.